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The author remarks that the reversible pendulum and its tripod, constructed by M. Repsold, are very convenient for transport and differential observations of the length of the seconds pendulum in different places; but, to obtain the correct length in any particular place, recourse must be had to a series of observations difficult to execute with precision. He suggests that the pendulum should be suspended at a given place, as well from its actual tripod as from a solid support fixed in a wall, as by Captain Kater and other English observers. The comparison of the time of oscillation for these two methods of suspension would be sufficient to determine the correction depending on the flexibility of the tripod.

The Memoir is dated January 11, 1879.

On a New Method of determining Astronomical Refractions.

By David Gill, Esq.

The law of astronomical refraction is by no means known with certainty. Bessel and Nyren have, it is true, arrived at very similar results on different hypotheses, but the state of our knowledge of refraction (especially beyond 80° zenith distance) is not satisfactory.

The ordinary well-known method of determining refraction is to observe the zenith distance of stars at their upper and lower culmination. Then, with an assumed latitude of the Observatory and an assumed law of refraction, to calculate the polar distances, and finally to find such a correction to the assumed latitude and assumed law of refraction as shall reduce the sum of the squares of the residuals to a minimum. The whole question then becomes a very involved one, for it includes, besides an imperfectly known law of refraction, all the unknown errors of division of the circle, the errors of flexure, &c., which are so difficult to determine completely.

I think, therefore, that a perfectly independent method of determining the absolute refraction at any altitude, and which is entirely independent of any assumed law, is not only a great desideratum in practical astronomy, but a subject of much interest as a physical research. I therefore lay the following proposal before the Society in its present form with the hope of benefiting, in the after practical application of the method, by the suggestions of the Fellows.

To fix our ideas:

1. Let us suppose an Observatory situated on the Earth's Equator.

2. Let this Observatory be provided with an instrument on

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the principle of what is now commonly known as a Talcott's Zenith Telescope, and this telescope be provided with horizontal wires, over which the vertical transit of a star may be observed.

3. At such a station suppose two stars whose declination is 0°, and whose difference of right ascension is known. If vertical transits were observed with such an instrument at exactly equal zenith distances on opposite sides of the zenith, then the arithmetical sum of the hour angles will differ from the true difference of right ascension of the stars by twice the refraction.

4. The apparent altitude would be obtained directly from the apparent hour angle and the known declination and latitude of the place; hence we have directly what we want, viz. the true refraction for an apparent altitude.

It is quite true that the case I have supposed is the most favourable possible; but at Observatories of considerable latitude the method may still be employed with every prospect of success.

It is only necessary to select stars of such declination that they are on the prime vertical about the altitude at which we desire to investigate the refraction, and so observe the refraction in right ascension.

A small error in the declination of the star or latitude would then have no sensible effect in the result.

The conditions necessary to complete success appear to be:—

(*a*) A proper selection of stars *of uniform magnitude* which shall be on the E. and W. prime vertical in convenient pairs for the investigation of refraction at each required zenith distance, and so that there shall be a short convenient interval between the observation E. and W. at the same zenith distance.

(*b*) The rigid determination of the right ascensions of all these stars by the same observero makes the observations of vertical transits.

(*c*) The use of a reversing prism in front of the eyepiece, so that all the stars may be observed to pass through the field *apparently* in the same horizontal direction; or, better still, be observed over half the wires in one direction, and over the other half of the wires in the opposite direction.

(*d*) The construction of an equal-altitude instrument, capable of preserving the mutual rigidity of its parts for 20 minutes of time.*

(*e*) The accurate determination of the declinations of the stars. This could be done very rigidly by the method of Struve by observations in the prime vertical.

(*f*) The continuation of the observations for at least a year to eliminate the possible periodic errors of the right ascensions, and the employment of an underground clock in an airtight case.

(*g*) By confining the observation to 7th mag. stars, a sufficient selection would be obtainable, and at the same time the

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* I shall present a description of such an instrument at a future Meeting.

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errors due to personality in right ascension depending on magnitude would be avoided.

It is to be remarked that this method is most useful for low latitudes; but that is precisely where the greatest difficulties are encountered in the other method.

It is also to be remarked that the method is *entirely* free from systematic instrumental error.

On the Change in the Errors of Hansen's Lunar Tables between 1848 *and* 1876. By W. T. Lynn, B.A. (London).

In the *Monthly Notices* for 1860, June 8 (vol. xx., p. 320), the Astronomer Royal gave a series of comparisons of places of the Moon derived from Burckhardt's and from Hansen's Lunar Tables, with places obtained from the Greenwich observations made with both the Transit Circle and the Altazimuth instruments, for the years from 1847 to 1858. The result showed, as is well known, an immense superiority during that time of Hansen's over Burckhardt's Tables; but an impression has gained ground that the former have not in more recent years represented the Moon's place nearly so well as they did at that period. I have thought it worth while to calculate for one recent year the sums of the squares of the Moon's errors deduced from comparing the *Nautical Almanac* places (derived from Hansen's Tables) with those obtained from the Greenwich observations, and to compare them with those of one of the earlier years, the results of which were furnished by the Astronomer Royal. In doing so, I have selected the year 1876 as the last of which the Greenwich observations have been published, and compared its results with those of 1848, the earliest in which Altazimuth observations were made throughout the year. These years are separated by an interval of twenty-eight years, and the sums of the squares of the errors in longitude and ecliptic north polar distance are as follows:—

1. *From Observations with the Transit Circle.*

Year.	No. of Obs.	Sums of Squares of Errors of Longitude. ″	Sums of Squares of Errors of E.N.P.D. ″
1848	113	1132·64	810·21
1876	82	8433·37	466·88

2. *From Observations with the Altazimuth.*

Year.	No. of Obs.	Sums of Squares of Errors of Longitude. ″	Sums of Squares of Errors of E.N.P.D. ″
1848	199	2567·76	1989·89
1876	171	17605·94	1696·33